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SCIENCE

FRIDAY, MARCH 4, 1910

SOME REFLECTIONS UPON BOTANICAL
EDUCATION IN AMERICA¹

CONTENTS

<i>The Botanical Society of America:—</i> <i>Some Reflections upon Botanical Education in America:</i> PROFESSOR W. F. GANONG ...	321
<i>Presentation of the Langley Medal to the Wright Brothers:</i> DR. ALEXANDER GRAHAM BELL	334
<i>Memorial to the late Morris K. Jesup:</i> DR. HENRY FAIRFIELD OSBORN	337
<i>The Fourth Annual Report of the Carnegie Foundation</i>	339
<i>Scientific Notes and News</i>	340
<i>University and Educational News</i>	344
<i>Discussion and Correspondence:—</i> <i>A Substitute for Cross Wires in the Spectroscope:</i> C. M. CLARK. <i>Note on some Pennsylvania Fishes:</i> HENRY W. FOWLER .	344
<i>Scientific Books:—</i> <i>Die Geographische Verbreitung der Schmetterlinge:</i> DR. W. J. HOLLAND	346
<i>Quotations:—</i> <i>The Length of Service Pensions of the Carnegie Foundation</i>	348
<i>Special Articles:—</i> <i>Dipylidium caninum in an American Child:</i> DR. WM. A. RILEY	349
<i>Anthropology at the Boston Meeting:</i> DR. GEORGE GRANT MACCURDY	350
<i>Societies and Academies:—</i> <i>The Indiana Academy of Science:</i> J. H. RANSOM. <i>The Kansas Academy of Science:</i> J. T. LOVEWELL. <i>The Chicago Academy of Sciences:</i> WALLACE W. ATWOOD. <i>The Biological Society of Washington:</i> D. E. LANTZ. <i>The Botanical Society of Washington:</i> W. W. STOCKBERGER. <i>The Anthropological Society of Washington:</i> I. M. CASANOWICZ	355

IN the address with which he welcomed the American Association for the Advancement of Science to Columbia University three years ago, President Butler centered his remarks on a matter of the first scientific and educational importance. He said, in effect, that for a quarter century he had been a close and friendly observer of the progress of the sciences in education, that during this time he had seen them win almost complete recognition and opportunity, but that he was obliged to confess to some disappointment at the results. He was not referring to the sciences in technical education, for in this field their status is satisfactory, but to their position in general or cultural education. He did not presume, he said, to suggest either an explanation or a remedy, but he submitted the matter to the consideration of his expert audience. These words of this eminent educational observer touched an answering chord in my own thoughts, and since that time I have found, by inquiry among my colleagues, that he voiced a feeling quite general among scientific men themselves. It seems, therefore, to be a fact that the sciences, although dealing in knowledge of matters of the greatest immediate interest, and although concerned with the most elemental of all trainings—that in the correlated use of hand, eye and mind—are still of mediocre efficiency as factors in general education. I propose now to discuss briefly the reasons I have been able to find for this

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¹ Address of the retiring president of the Botanical Society of America, delivered at Boston, December 28, 1909.

undesirable condition of a part of our scientific affairs, and to suggest, with particular reference to our own beloved science, some remedy therefor.

It will help to clarify our problem if we can come to an understanding upon certain points in the general relations of the sciences to education, the first being this—what place ought the sciences to have in education? I think we shall agree that the sciences can never, under any circumstances, hold a place in education nearly as prominent as that of the humanities. Man is not primarily a reasoning but a feeling being. As a philosopher has expressed it, “few men think at all and they but seldom.” Hence the great majority of people in most part, and all people in some degree, can best be reached and influenced by studies which appeal primarily to the feelings, that is, by the humanities, while it is only a minority which can best be reached by studies appealing chiefly to the reason—that is, by the sciences and mathematics. But a minority has rights, and those to whom the sciences especially appeal, and to whom therefore they are of the higher cultural value, are just as entitled to efficient instruction in their subjects as are the majority in theirs. The sciences must always hold, from their nature in conjunction with that of humanity, a position quantitatively inferior to that of the humanities, but they are entitled to a qualitative equality of educational rank and opportunity. This they do not yet possess, and it is alike our duty and our interest to see that they shall.

A second point of importance in the general relations of the sciences to education is involved in the fact that the times themselves are a bit out of joint, educationally speaking. This is not a matter of individual opinion, but of well-nigh universal agreement. The recent addresses of our

younger college presidents have united in expressing dissatisfaction with the results derived from our superb educational equipment, while the remarkable declaration of principles of the National Educational Association, issued a year and a half ago, recognizes an equivalent condition for the schools. It is a fact that our students as a whole have many hazy impressions but little exact knowledge, are habitually inaccurate even in the three r's, and have too little regard for intellectual matters. The cause of it all is obvious enough. Our education, step by step with our modern life, has become luxurized. Its features disagreeable to young people have been sedulously softened, their whims are determinants of educational programs, and the responsibility for learning has been largely shifted from them to their teachers. The wise Mr. Dooley has the modern college president say to the incoming freshman: “What branch iv larnin’ wud ye like to have studied f’r ye be our compitint proffessors?” and his humor as usual illumines a central kernel of truth. The trouble with our education is this, that it needs more starch; yea, it needs a bit more blood and iron. It ignores the fact that, with the mind as with the body, it is only through effort that strength can be gained, and through responsibility that character can be formed. It is not more work our students need, but work of a kind which does more to inculcate a willingness for effort, and pride in a Spartan devotion to duty—of a kind which enkindles in the heart of youth the precious spark of intellectual ambition. I would not exaggerate the defects of our present-day education. I know they do not go to the vitals, and certainly they are more serious in some places than others. But this granted, there yet remains too great a deficiency, especially in educational morale. Our col-

leges are not going to the dogs, but they certainly permit some very queer mongrels to roam at large on the campus.

Now the application of these remarks to our present problem is doubtless sufficiently plain. In an educational system which too much permits inaccuracy of work, indefiniteness of knowledge, avoidance of effort, and whimsical selection of studies—in such a system the sciences, whose essence is care, exactness, persistence and consistency, have not a wholly fair chance. One of the principal reasons, therefore, why the sciences do not loom larger in present-day education is the fault of that education and not of the sciences.

A third point of importance in the educational status of the sciences is involved in the fact that they have not as yet had time to become organized and standardized for their most effective educational use. The humanities have behind them so many generations of experience that they are now measurably standardized throughout, and offer a continuous and suitably-graded training from kindergarten to college. But the sciences as laboratory-taught subjects are not much more than a single generation old, and many of their problems are still unsettled. In the higher grades our teaching is better than in the lower, while, as everybody knows, we are still far from any consistent and continuous system of instruction in nature knowledge in the lower schools. Just here lies a great weakness of scientific education at the present day, for students too often are sent into high school and college not only without the positive advantage of good early training, but even with a prejudice against a kind of activity of which they have had little, or too often an unfortunate, experience. This condition is inevitable to the youthfulness, educationally, of the sciences, and will be remedied in time.

The last point I would mention in the educational relations of the sciences to the older subjects is this, that the sciences are under some minor disabilities from which the others are free. These center in the laboratory, and are connected in part with the fact that the laboratory type of study, with its mechanical manipulation, its fixed hours and methods of work, and its absolute requirement of independent observation, is distasteful to the great majority of persons, who, whether by natural inclination or acquired habits, prefer to absorb their knowledge in physical ease, by methods which can be lightened by the wits, and from printed books upon which they can lean for authority. Again, laboratories are expensive, much more expensive than the equipment of the other subjects. This acts as a check to the sciences all along the line, while in poorer communities it is often determinative against their introduction at all.

Now it may seem, at this point, that I have needlessly infringed on your patience and my own allotment of time in thus enumerating such obvious matters, but in truth I have had a good object, which is this: I wish to emphasize that all of these disabilities under which science-teaching now labors, these elements of our problem which are not our own fault and for the most part are beyond our control, and the list of which I have made as long as I could,—all of these taken together go only a very small way towards explaining the deficiency of the sciences in education. This deficiency, I believe, is for the most part our own fault and removable, and it all centers in this, that we are not teaching our subjects properly. And now I have reached the real theme of my present address.

Whenever we are faced by any large problem, we tend to seek its solution in some single great factor. Yet, as the phe-

nomena of our own science so often illustrate, the solution is as likely to be found in the cumulative action of several small causes, and such I believe to be true of the problem before us. These causes are some four in number, of which the first appears to be this—*we are not faithful to the genius of our subject.*

The genius of science consists in exact observation of real things, critical comparison of actual results, and logical testing of the derived conclusions. The educational value of science consists in a training in these things, and our teaching should reflect them. Yet in fact in too great part it does not. For one thing we have joined in the rush to render our subjects popular, a spirit which is one of the pernicious by-products of the elective system under which most of us work. Our subjects being elective, students will not take them unless they are made attractive: our success as teachers is largely judged by the number of students we can charm into our courses: our colleagues stand ready to cry "snap" to any course which grows faster than they can see cause for: therefore the logical procedure for the teacher is to draw great numbers but keep them complaining of the work, and he is the greatest teacher under this system who can attract so many students that a new building must be provided immediately, while their lamentations over the difficulty of the course are loud enough to reach the ears of all of his colleagues! Now this condition can be attained with quantity, though not with intensity, for most students will not elect a course involving intensive work which they can not escape, but they are willing to elect one in which the work may be eased by the wits, no matter how copious the irrigation of information may be. Just here indeed is a very fundamental trouble with our education in general. We are teaching our stu-

dents to gobble when they need to be taught to fletcherize.

Another phase of our treason to the genius of science is found in the belief and practise of some teachers that broad generalizations are the true aim of elementary teaching. I know a recent elementary textbook in which the author laments that "some teachers do not yet understand the importance of imparting to beginners a general rather than a special view point." And I could cite many passages to show a belief of this and some other teachers that subject matter, accuracy in details, and other fundamental verities of science, are not important in comparison with viewpoints and outlooks on life and that sort of thing. In my opinion there can be no greater educational error. There is no training which American youth needs more than that in a power to acquire knowledge accurately and to work details well. Disregard for particulars and a tendency to easy generalities are fundamental faults in American character, and need no cultivation, but, instead, a rigorous correction.

Another phase of our disregard of the genius of science is found in the bad character of some of our elementary teaching. Our plant physiology in some cases is so erroneous that it is only the general badness of our teaching which saves us from the humiliation of having our errors pointed out by those we are trying to teach. Our elementary experiments ought to be conducted in the spirit of rigid control, just as carefully as in any investigation. The motto in the experimenting recommended by our text-books seems to be, "the easiest way that will give a result in agreement with the book," and we seem not to care whether that result is logically or only accidentally correct. In this spirit is the use of make-shift and clumsy appliances instead of accurate and convenient ones,

something which is justifiable only when no better can possibly be had. Such slipshod and inaccurate ways are not only wasteful of time and effort, but are actually pernicious because they inculcate a wrong habit and ideal of scientific work. I do not mean at all, here or anywhere, that young pupils should be made to study advanced scientific matters or to use technical methods, but simply that the treatment of their subjects according to their grades should be strictly scientific in spirit as far as it goes. Moreover, any attempt to avoid this spirit is the more unfortunate because needless, for as a matter of fact the great majority of young people respect exactness, and really like to be made to do things well. They do not like the process at first, and will avoid it if they can, but they like the result, and if the process be persisted in they come in time also to like that.

In a word the first great need of our science teaching is to make it scientific.

The second of the four principal causes of our inferior teaching is this, *we take more thought for our subject than we do of our students*. In the graduate teaching of a university this attitude is logical, but in college and school it is wholly wrong. I think we may express the matter thus, that any teacher who is more interested in his subject than in his students is fit only for a university. It is, I am sure, somewhat more characteristic of scientific than of other teachers that they tend to shut themselves up in their subjects, and to withdraw more than they ought from the common interests, duties and even amenities of the communities in which they live. For this, of course, the very attractiveness of science is largely responsible, because to those who have once passed the portals, science offers an interest so vastly and profoundly absorbing that all other matters appear small by comparison; and we are

apt to conclude that the nobility and beneficence of such a mistress are sufficient justification for a complete immersion in her service. We forget that science has no existence apart from humanity, and no meaning unless contributory, however indirectly, to human welfare and happiness. And it should be emphasized to every young teacher that success in science teaching, as in so many other occupations, is well-nigh in direct proportion to one's ability to influence people. Our science teaching would be better if our teachers trusted less to the abounding merits of their subjects, and more to the qualities which personally influence young people—the sympathetic qualities involving interest in their pursuits, the diplomatic qualities involving the utilization for good purposes of the peculiarities of human nature, the perfecting qualities involving the amenities and even the graces of life. There is no inconsistency between these things and the preservation of the scientific quality of the teaching. It is simply a question of the presentation of science in a manner which is humanistic. It is the gloving of the iron hand of the scientific method by the soft velvet of gentle human intercourse. Science is the skeleton of knowledge, but it need lose nothing of its strength and flexibility if clothed by a living mantle of the human graces. It is idealism with realism which is demanded of the science teacher, and if some one would rise to say that this union is logically impossible I would answer, that many a problem of this life unsolvable by the subtleties of logic can be settled by robust common sense.

Of our over-neglect of the personal peculiarities of our students I know several illustrations, but have space only for one. Young people appear to have in them some measure of Nägeli's innate perfecting principle, which leads them upon the

whole to respect and like those things which are good and clean and dignified, a feeling which manifests itself in their strivings after good clothes, good society and things supposedly artistic, not to mention innumerable longings after the lofty unattainable. Now a dirty or carelessly-managed laboratory is a direct shock to this feeling, and most scientific laboratories sin in these features. I believe there is no part of a college or school equipment which ought to be prepared and managed with more care than a scientific laboratory. Efficiency for its purpose is of course the first requisite of any laboratory, but in college or high school that efficiency should be secured with attention to the utmost of pleasing effect, in the direction of a large simplicity, evidence of care for each feature, and an atmosphere of spacious and even artistic deliberation. As an example of what can be done by good taste to give a pleasing setting to the most unpromising objects, I commend the New York Zoological Park, which embodies an idea much needed in most of our botanical institutions. We ought not to permit the accumulation of dusty and disused articles around laboratories any more than around libraries: our teaching museums should contain no crowded accumulations of half-spoiled specimens in leaky green bottles, but only a selection of the most important, and those in the best of receptacles well labeled and tastefully displayed. Our experiments with plants should not exhibit dirty pots on untidy tables, but every plant should present an aspect suggestive of considerate care, while all the surrounding appliances should glitter with cleanliness and stand on a spotless table widely enmargined with space and neatness. One of my friends in a neighboring college has said of the methods of my laboratory that they savor of the old maid. I take pride

in this compliment, for it shows I am advancing. All of these qualities of care, neatness, concentration upon a few large and worthy things, can be made to appeal greatly to youth, as I have learned from experience. Besides, they are scientific, and they are right.

There is yet one other phase of this subject of humanism in science teaching which I wish to emphasize. I think we do not make enough use in our teaching of the heroic and dramatic phases of our science, of the biography of our great men and the striking incidents of our scientific history. I know that their use is attended with dangers, dangers of false sentimentalism, of substitution of weak imagery for strong fact, of complication with religious prejudices; and they should therefore be introduced only as the teacher grows wiser. But when the tactful teacher can employ them to touch the higher emotions of his students, he should do so. The imagination is as necessary a part of the equipment of the man of science as of the man of letters or of art, a matter which has been illuminated with all his usual skill by President Eliot in his great address on the new definition of the cultivated man. When Darwin wrote his famous passage on the loss of his esthetic faculties he was a little unfair to his science and a good deal unfair to himself. For he never mentioned the compensation he had found in the intensity of lofty pleasure derived from his acquisition of new truth. Science hath her exaltations no less than poetry, music, art or religion. Not only is the feeling of elation which comes to the scientific investigator with the dawning of new truth just as keen, just as lofty, just as uplifting as that given by any poetry, any music, any art, any religious fervor, but they are, in my opinion, the same in kind. There is but one music heard by the spirit, and that is

in us, whether it seem to come from the spheres, from the lyres of the muses, or from the voices of angels, and it gives forth when the last supremest chord in the soul of man is touched, it matters not by what hand.

We come now to the third of the causes which make our teaching of science defective, and it is this—*we put our trust too much in systems and not enough in persons*. And of this there are many evidences. For one thing we rely too much on a supposed virtue in buildings and equipment, though in this we but share the spirit of our machinery-mad day and generation. It is much easier for us Americans to obtain great laboratories and fine equipment than to make good use of them afterwards, and nowhere among us do I see any signs of a Spartan pride in attaining great results with a meager equipment. Moreover, we make a deficiency of equipment an excuse for doing nothing. As one of the most brilliant of American botanists once said, some persons think they can do nothing in the laboratory unless provided with an array of staining fluids which would make the rainbow blush for its poverty. A second evidence of our confidence in systems is found in the easy insouciance with which university professors proceed to write text-books for high schools. The only qualification the most of them have therefor is a knowledge of their subject, and they seem to regard any personal acquaintance with the peculiarities of young people, and with the special conditions of high school work, as comparatively negligible. In consequence these books are necessarily addressed to some kind of idealized student, usually a bright-eyed individual thirsting for knowledge. This kind does exist, but in minority, whereas the real student with which the high school must deal is one of a great

mass willing to learn if it must. Confirmation of the correctness of my view that knowledge of students is as important as knowledge of subject for the writing of a high school book is found in the fact that the author of the botanical text-books most widely used in the high schools of this country has had only a high school experience. Another phase of our belief in the sufficiency of systems is found in the utterly unpractical character of many of the exercises or experiments proposed for the student in some of our books. These recommendations have obviously been worked out in the comfort of the study chair, and have never been actually tested in use by their suggestors; yet they are presented in a way to make the student feel that he is either negligent or stupid if he fails to work them. These theoretically constructed schemes for elementary teaching, and these recommendations of untried and impracticable tasks for students, sometimes run riot in company with sweeping denunciations of our present laboratory courses, and suggestions for their replacement by hypothetical field courses, utterly regardless of the fact that the former, whatever their faults, have been evolved in actual administrative adaptation to the real conditions of elementary work, while the proposed substitutes are wholly untried, and in the light of actual conditions, wholly impracticable.

On the other hand, there is one particular in which we have not system enough, and that is in the standardization of nature study and elementary science courses. I have already mentioned the advantage the humanities have in the approximate standardization of their instruction throughout the educational system, and towards this end for the sciences we ought to bend every effort. For one thing we should give all possible aid and comfort

to our nature-study experts in their efforts to develop a worthy system of nature study in the grades. Again, the peculiar relation of preparatory schools to colleges in this country makes it imperative that we develop standard elementary courses which any school can give with assurance that they will be accepted for entrance to any college. Happily we are here upon firm ground, for we already possess such a standard course, or unit, in that formulated by a committee of botanical teachers, now the committee on education of this society. This course is formulated upon the synthetic principle, that is, it selects the most fundamental and illuminating matters offered by the science without regard to its artificial divisions, and combines these in such manner as to make them throw most light upon one another. Its adaptability to our conditions, and its acceptability to our best educational opinion, is shown by several facts, by its adoption as the unit by the college entrance examination board which has been holding examinations upon it all over the country for six years past, by its use in innumerable high schools, by the agreement between its plan and that of all of the recent and successful text-books, by the final disappearance of all influential opposition to it, and lastly by the substantial concurrence of the unit now in formulation by the teachers of the middle west. With so firm a foundation in a plan we ought to be able to unite on perfecting details. There is no inconsistency between such standardization as this and the greatest freedom in teaching. The optical power of the microscope has not been injured by the standardization of its form and screw-threads.

I come now to the fourth of the reasons why our science teaching is defective, and that is the most vital of all. *Our method*

of training teachers is wrong. I believe it is true that in general our educational advances work down from above—from university to college, from college to high school and from high school to the grades; and in a general way each of these institutions is the finishing school for teachers of the grade below. Now the work of our universities is for the most part admirable in every way, but they are not good training schools for college teachers. One of the greatest of our college presidents lately remarked that the principal obstacle in the way of making a college what it ought to be is the difficulty nowadays of securing the right kind of teachers. "We have to take them as the universities supply them," he said, "and then make them into good college teachers afterwards." The defects of the universities in this respect are two-fold. First they are training students only for their own kind of activity, in which everything centers, very properly, in research: and second, they are omitting to teach divers matters very essential for the college teacher to know.

That our universities make research the central feature and great leading method of their training of graduate students is natural, logical and correct, so far as training for their own kind of activity is concerned; but it ignores the fact that only a minority can remain in that work. The justification of the training of all by a method which is correct only for a minority is usually expressed in this form, that he is the best teacher who is an active investigator. Now if this is qualified by the proviso, "other things being equal," it is approximately true; but in fact other things very rarely are equal, and in the matter under discussion they are profoundly unequal. In my opinion the imposition upon all university students of the university research ideal is doing vast

harm to our teaching in college and therefore in high school. For one thing, it sends out ambitious young men imbued with the feeling that they must maintain their research at all costs, or else forfeit the good opinion of their teachers, the possibility of membership in the best scientific societies, and especially any chance for a call to university work, though this latter point should not be given great weight, since to a person with a liking for teaching a good college offers as attractive a career as a university. In consequence there is continual pressure on the teacher to subordinate his teaching to research. Now in college and high school this is wrong, ethically and practically. A college teacher is never engaged for research, but for a very different purpose, and it is his first duty to carry out that purpose to the very best of his ability. If there is any man who can carry on active investigation and at the same time do college or high school work as well as if he were concentrating wholly on that, the man is fortunate, and so is the institution which has him. But in fact this can rarely be true. For one thing, the limitations of time and strength prevent it in most cases; and for another, the qualities and temper required for the two activities are not only different but somewhat antagonistic. Research requires concentration, and much consecutive time fixed by the nature of the work, while the teacher must be ready for constant interruptions, and must regulate his time to fit the schedules of his students. To one immersed in the crucial stage of an investigation the little troubles of students seem absurdly trivial, if not stupid, and under their application for aid he is almost more than human if he can keep a sweet temper and not answer with repellant brusqueness. To the good teacher, the troubles of students are never trivial, but

rather are welcome as means to the advancement of his particular interests. Furthermore, I believe that the research ideal imposed on all men trained in the universities is the cause not only of much injury to teaching, but of much unhappiness to teachers. For if the teacher be conscientious, and gives his first strength to his teaching, he is soon doing his research upon the ragged ends of his nerves. I venture to say that many a teacher to-day is wishing he could afford to abandon all attempts at abstract research and turn whole-souled to his teaching and matters connected therewith. And when, indeed, he does so, he finds his happiness and his usefulness alike immensely augmented. I know this is true, for I have been through it. It took me many long years to free myself from the feeling that I must continue research or else sacrifice the good opinion of my colleagues. But I am free, and in the two or three years I have been so the added keenness of my pleasure in my teaching, and in various activities related thereto, has been such as to make me feel like a Sinbad who has dropped his old man of the sea. And if there are any among you who believe that I stay in a society given to research only under false pretenses, I ask you to have patience a little, for I purpose to try to convince the society that its rules ought so to be altered as to make teaching, of approved merit and service, a sufficient qualification for membership. Meanwhile I advise all of my colleagues engaged in collegiate work to join in my declaration of independence. Let us show the universities that teaching hath her victories no less than research.

But now I am going to qualify a little. When I say research I mean abstract research, of the university type, the kind which has place on the skirmish line of the forefront of advancing knowledge. In

truth I agree that he is the best teacher who is also an active investigator, but I maintain that in the case of college teachers the investigation ought to have some kind of connection with the teaching. This is entirely possible, for a vast and fruitful field for research lies open in educational organization, in the introduction of more logical, useful and illuminating topics, experiments and methods, in the fitting of science better to the growing mind, in local floras and the natural history of common plants, in ways for better collation and diffusion of knowledge. After all, it is the spirit of investigation that is the matter of value to the teacher, not the results. A contemplation of the status of much of the investigation put forth by busy teachers somehow seems to suggest a saying of one of our senior botanists, who was in his youth somewhat of a botanical explorer, and always a genial wit. Apropos of the making of bread in camp he has been heard to remark that "it may not result in very good bread, but it's great for cleaning the hands." In investigation as elsewhere, results are most surely and economically won by experts, selected, trained and devoted to that work. The college teacher would do better not to waste his strength on a field in which he can be little better than an amateur, especially when there lies open another in which he can himself be an expert, and that is in educational-scientific investigation.

From this which the university ought not to do, I turn now to things which it leaves undone. It is not giving to those who are to be college teachers certain knowledge and training which are indispensable to good teaching. Thus, it does not insist that they shall know the common facts about the familiar plants around them. The old type of botanical course, consisting in the study of the morphology

and identification of the higher plants, is gone forever, not because it was not good, but because the expansion of knowledge has given us something still better. Yet the knowledge involved in the old course is indispensable to every teaching botanist, and I would have a requirement made that no person could be recommended as a competent botanical teacher for a college until he had spent at least two summers of active field work on the critical study of some flora. Again, most of our university-trained teachers know nothing more of the historical or biographical phases of the sciences than they may have picked up incidentally. Yet for purposes of teaching, a knowledge of the history of the science itself, and of its relations to other great matters, is vastly important, in part for the favorable background it offers for the projection of our present-day knowledge, and in part for the purpose of placing the dramatic, heroic and humanistic aspects of the science at the disposal of the teacher. Again, the teacher may go forth from the university without any other than the most fragmentary knowledge of laboratory administration, although there is a rapidly developing technique of efficient and economical management of laboratory construction, furniture, apparatus, supplies, materials, manipulation; and the lack of any training in these is one reason why our science is so often disgraced, and our influence weakened, by slovenly botanical laboratories. Again, the teacher takes up the instruction of young people without any knowledge whatever of the results, very valuable, all imperfect though they still are, which have been won in the scientific study of the psychology of the adolescent mind. And finally he receives no training in the collation and exposition of scientific knowledge, a subject of such importance that I shall speak of it in a moment apart. Training in

investigation he also needs, of course, and that he now gets with ample efficiency. We need a standardization of preparation for college and high-school teaching of the sciences, with appropriate titles or degrees. We are as yet far enough from such a condition, but not wholly without some progress to record. For one university, Chicago, in its school of education, has a department of botany and natural history, administered, by the way, by one of our members and colleagues whose accomplishments in the past give promise of great service to come.

But now once more I wish to qualify a little. While I believe that a training in common knowledge of plants, in the history of our science, in laboratory administration, in the psychology of youth, in the collation and exposition of knowledge, as well as in investigation, is indispensable to the best botanical teaching, and should be included compulsorily in the training of botanical teachers, I do not blame the universities for not providing such instruction, nor am I sure that it is a correct or economical university function. But there is one thing of which I am sure, and it is this, that there is a place in which such training is practicable and wholly appropriate and that place is the graduate department of the college.

Just here I wish to turn aside for a moment to consider a bit more this matter of training in the collation and exposition of knowledge. The expansion of science in our day has been so vast, the literature has become so voluminous, the specialization of method and thought are so extreme, that it is becoming a serious question how the results of new research, when not of a sensational nature, can be quickly, accurately and adequately incorporated into the general mass of our knowledge and made available to the intellectual or economic uses of our

race. Every scientific man has witnessed the ignoring of new truth long after its announcement, and the repetition of old error long after its disproof, not alone in popular information and literature, but even in the best scientific text-books; and this mal-adjustment between scientific research and general knowledge waxes constantly greater. The trouble is plain; we have no recognized collators of knowledge, scholars whose business it is to stand between the investigator and the general user of knowledge and to interpret correctly the results of the one to the other. The need for such service was pointed out long ago by Francis Bacon. In his prophecy of the future development of scientific knowledge, veiled under his story of "The New Atlantis," he describes the division of duty among the scholars of Salomon's House. He says:

Then after divers meetings and consults of our whole number, to consider of the former labours and collections [an obvious prophecy of our scientific meetings], we have three that take care, out of them, to direct new experiments, of a higher light, more penetrating into nature than the former. These we call Lamps. . . . Lastly, we have three that raise the former discoveries by experiments into greater observations, axioms, and aphorisms. These we call Interpreters of Nature.

To-day we have our lamps, and their light shines steadily and benignantly forth. We call them universities. But where are our interpreters of nature? Though we need them, we have them not. They should be our colleges. In all of the great body of intellectual endeavor there is no greater weakness and no greater opportunity for service, than in the interpretation to all men of the results secured by research, not in science alone, but in other departments of knowledge as well. It is the absence of such interpreters which leaves room for the charlatans of knowledge, the mendacious reporter who uses his bit of college information to give a specious semblance of

truth to his inventions or exaggerations, and the nature fakir whose literary skill is his sole qualification. This interpretation of knowledge is no easy matter. Compilation will not do, for the interpreter must repeat observations and experiments far enough to give him a personal and familiar grasp of the materials. Nor even is a first-hand knowledge of the materials enough; he must also be able to set them forth in exposition with a combination of pedagogical clearness and literary force. So little developed is the interpretation of knowledge in comparison with its acquisition that although we have many strong journals devoted to research we have almost none devoted to interpretation and exposition. We have two or three popular journals, carried on by the devotion of loyal individuals, but with all the conditions for success against them. A suitable journal for the collation, interpretation and diffusion of botanical knowledge can only be conducted by an institution whose credit is involved in its permanence and efficiency. It should be marked by dignified form, artistic dress, and literary grace, with departments covering so completely their fields that no person with a serious interest in the science can possibly afford, and much less be willing, to be without it. Such a journal must of course be heavily subsidized, or endowed, especially at first; but there is not at present any place in the educational structure where an endowment would tell so heavily. It would be worth more to education than the endowment of any professorship that I can think of, even a professorship of botanical education in my own college. Such a journal should issue from a college, not a university. I would like to edit it, and I have the plans worked out in complete detail; but I shall not undertake it unless the business foundation can first be made secure.

Not only does the training of interpreters of nature, and of other knowledge as well, whether as teachers, as writers, through the editing of suitable journals, or other activities, seem wholly appropriate to a college, but I think it would offer the colleges themselves a mission which would react grandly on their general efficiency. There is an agreement that the first function of the college is the training of young people in the qualities which go to make more effective members of organized human society. But there is also a general feeling that somehow this is not by itself quite sufficient, for while it offers a worthy and amply difficult educational service, it does not provide a sufficiently-absorbing intellectual interest. Our colleges require, for the maintenance of high intellectual tone, both of students and of teachers, some more vigorous intellectual resistance than undergraduates alone can offer. It is in response to this feeling that some colleges have established graduate work, but in all cases, so far as I know, of the investigation or university type. For such work, however, our students should be sent to a university, which can provide far better than any college the facilities, companionship and atmosphere essential to its successful pursuit. To encourage young people, who are never well informed upon these matters and who do not understand the differences between institutions, to come to a college for work of the university type, is little better than attracting them under false pretenses. It would be much better for our educational system if the colleges would do no graduate work at all, unless they can offer something which they can do better than the university. In the training of their own and high-school teachers, and other interpreters of knowledge, they have, from the very nature of their activities and the presence right at hand of the best of all practise

schools, a work which they can do better than the university. I hope ere long to see, in one of our greater colleges, the establishment of the first graduate school devoted to the training of these interpreters of knowledge.

But now I have reached the bounds which custom and courtesy allow to a speaker for this kind of address, and although I think with regret of the many large matters I fain would include to make my account of this subject complete, I must come to a close. I shall add but one thing, which is this—a summary of the objects for which we should work.

1. A continuous and adequate system of nature study in the schools, so complete and so good as to send every student into the high schools with no prejudice against science, and with a solid foundation of natural fact knowledge.

2. A four-years' course in the high school in the standard sciences, upon exactly the same basis of efficient teaching and educational dignity as any other subjects whatever, being required in so far as they are required, and elective in so far as they are elective.

3. A system of education in the college which will preserve the golden principle of the elective system—viz., the fact that the mind like the body derives greater good from an exercise in which it can take an interest than from one in which it does not—while pruning away the absurdities that have been allowed to graft themselves thereon. The logical system is the group system, in which the student is free to choose his group, but having once chosen it, finds his studies arranged on a plan approved as wise by educational experience. We must not expect a majority ever to choose the science groups, but those who do should receive a training qualitatively equal to that in any subjects whatever, and,

above all, thoroughly but humanistically scientific.

4. A critical review and retesting of our present educational methods and material, with a view to the elimination of the impracticable, the replacement of the mediocre, and the introduction of better, to be sought through critical educational research.

5. A system of training of teachers which shall recognize that college teachers and university investigators are not one and the same, but fellow craftsmen, entitled to equal honor for equal achievement. The training of the university investigator belongs to the university, but of the college teacher to the college, which should establish the suitable instruction in the practical and humanistic phases of the subject. And since the college teacher is from his profession primarily an interpreter of knowledge, he should make that his particular field; and the colleges should cherish and develop, as their particular function, all activities connected therewith.

These things, I believe, will make the sciences free from their present educational disabilities. It is true they will not give us perfection. But what is perfection, and who wants it? Perfection, so I fancy, for I never have seen it, is in this like truth, that there is more pleasure in seeking than in finding it. Besides, man, for whom we are doing it all, is imperfect, though the extent thereof depends upon the point from which we view him. If one were to look down upon him from the place of the angels towards which he likes to believe he is ascending, he must seem a very poor creature, deserving only of pity. But if one looks up after him from the place of the beasts from which we know he has risen, then he looms as a very grand figure, worthy of credit and honor. After all, perfect or imperfect, good, bad or indif-

ferent, he is the very best thing of which we are sure. It behooves us, therefore, to make the most of him.

W. F. GANONG

SMITH COLLEGE

PRESENTATION OF THE LANGLEY MEDAL
TO THE WRIGHT BROTHERS¹

Mr. Chancellor: The award of the Langley medal to the Brothers Wilbur and Orville Wright emphasizes the fact that we are living in an age of great achievements.

The twentieth century had hardly dawned when the world was startled by the discovery of radium, which has opened up an entirely new field to science, and which has led us to modify profoundly our conceptions regarding the constitution of matter.

Another new field has been revealed to us through the development of wireless telegraphy and telephony; and we now utilize the vibrations of the ethereal medium of space for the transmission of thought.

Then again, we may note the most revolutionary changes going on before our eyes relating to methods of transportation.

The appearance of the hydroplane-boat probably foreshadows a revolution in marine architecture and propulsion. On land we see motor-cycles, automobiles and electric cars displacing the horse. Petroleum and electricity have become powerful rivals of steam; and we seem to be on the eve of a revolution in our methods of railroad transportation, through the application of the gyroscope to a monorail system. And now aerial transport has come, dispensing with rails and roads altogether. The air itself has become a highway; and dirigible balloons and flying machines are now realities.

¹Historical address by Dr. Alexander Graham Bell at the Smithsonian Institution, February 10, 1910.

How well the predictions of Langley have been fulfilled. We now recognize that he was right, when he said a few years ago (1897) that:

The world, indeed, will be supine if it do not realize that a new possibility has come to it, and that the great universal highway overhead is now soon to be opened.

It has been opened; and who can foretell the consequences to man?

One thing is certain: that the physical obstacles to travel have been overcome; and that there is no place on the surface of the globe that is inaccessible to civilized man, through the air.

Does this not point to the spread of civilization all over the world; and the bringing of light to the dark continents of the earth?

THE PIONEERS OF AERIAL FLIGHT

Who are responsible for the great developments in aerodromics of the last few years? Not simply the men of the present, but also the men of the past.

To one man especially is honor due—our own Dr. S. P. Langley, late secretary of the Smithsonian Institution. When we trace backwards the course of history we come unfailingly to him as *the great pioneer of aerial flight*.

We have honored his name by the establishment of the Langley medal; and it may not be out of place on this, the first occasion for the presentation of the medal, to say a few words concerning Langley's work.

LANGLEY'S WORK

Langley devoted his attention to aerodromics at a time when the idea of a flying machine was a subject for ridicule and scorn. It was as much as a man's reputation was worth to be known to be at work upon the subject. He bravely faced the issue, and gave to the world his celebrated